Fermilab Neutrino Beamline to DUSEL

Mike Martens

Fermilab PAC

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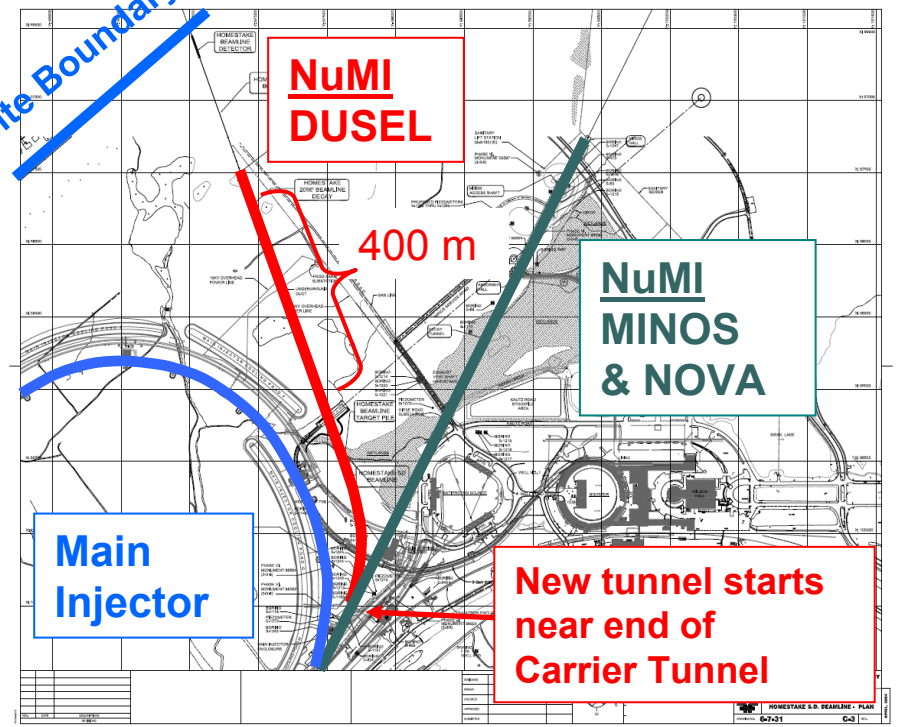
Neutrino Beam to Homestake



Fermilab to Homestake DUSEL (1290km)

Beamline Requirements*

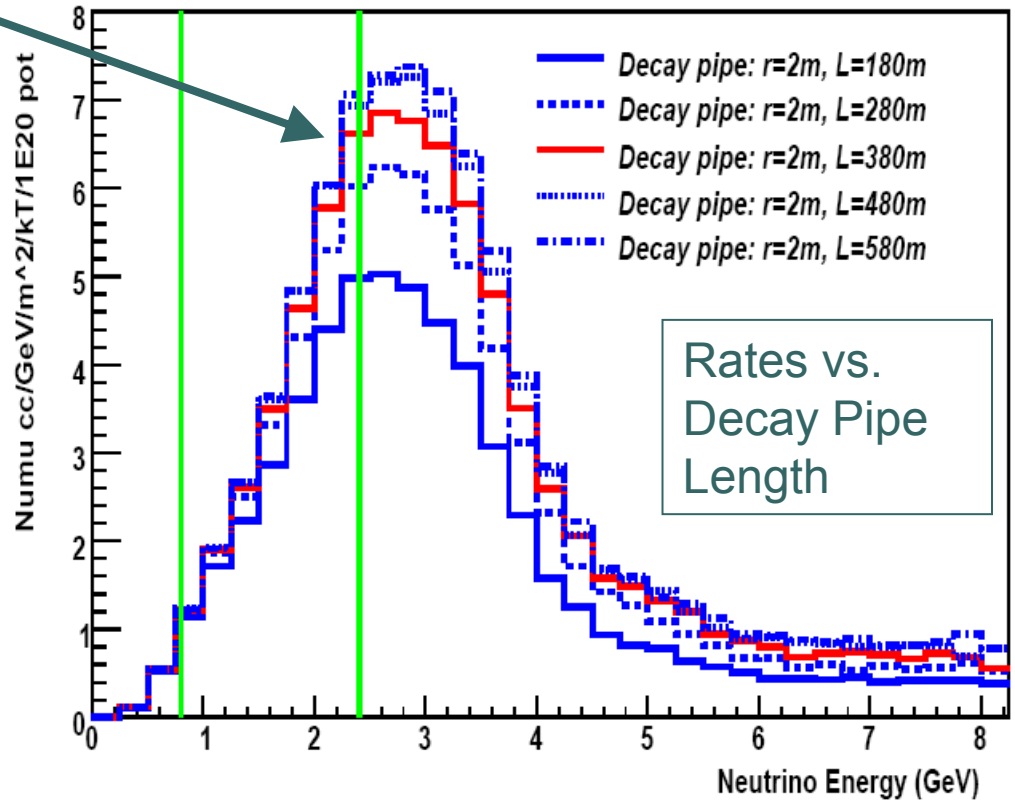
- **Large Flux of Neutrinos**
  - 700 kW $\Rightarrow$ 2.3 MW proton beam power (reliably) on target
- **Maximum CC events at 1st and 2nd oscillation nodes**
  - 2.4 GeV and 0.8 GeV
  - ν cross-sections scale with energy $\Rightarrow$ larger flux at lower E
- **For $\nu_\mu \rightarrow \nu_e$ minimize NC contamination at lower energy**
  - Minimize the flux of neutrinos with E > 5 GeV
- **High purity ν_μ beam**
  - Reduce background from beam generated ν_e

*From "Simulation of a Wide-Band Low-Energy Neutrino Beam for Very Long Baseline Neutrino Oscillation Experiments", Bishai, Heim, Lewis, Marino, Viren, Yumiceva

Target/Horn Configuration (Preliminary Results)

Mary Bishai

- On-Axis Spectrum
- 120 GeV Proton Beam
- Carbon Target in Horn 1
- NuMI horns @ 250 kA
- Horns 6 meters apart
- Decay Pipe
  - Radius = 2 m
  - Length = ~400 m



Would like to get more flux at ~1 GeV

DUSEL Beamline Working Group

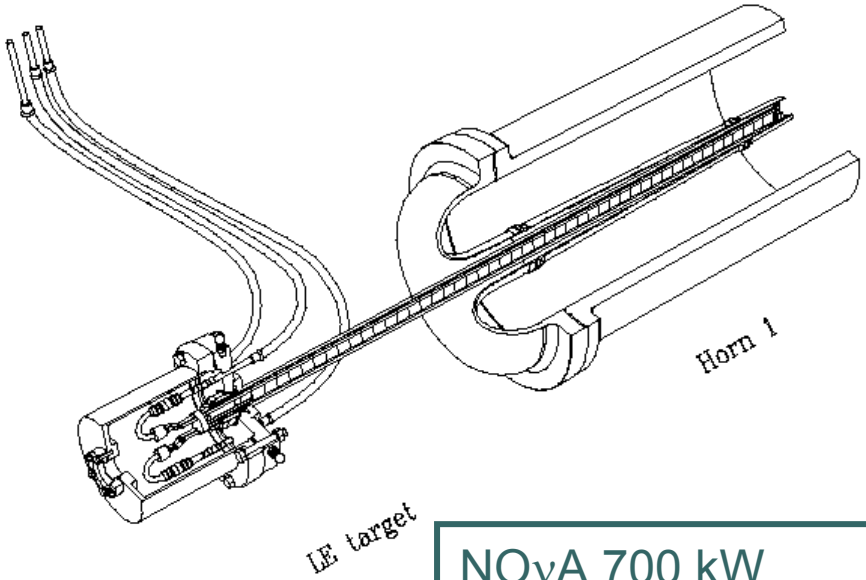
- Many people with NuMI experience
- FNAL, ANL, BNL, LBNL members
- NuMI Lessons Learned
  - Extraction and Primary Beamline
  - Decay Pipe and Windows
  - Target Hall Experience
  - Underground Topics
  - Public Participation
  - Tritium Experience
  - Radiology
  - ES&H

Common Themes:

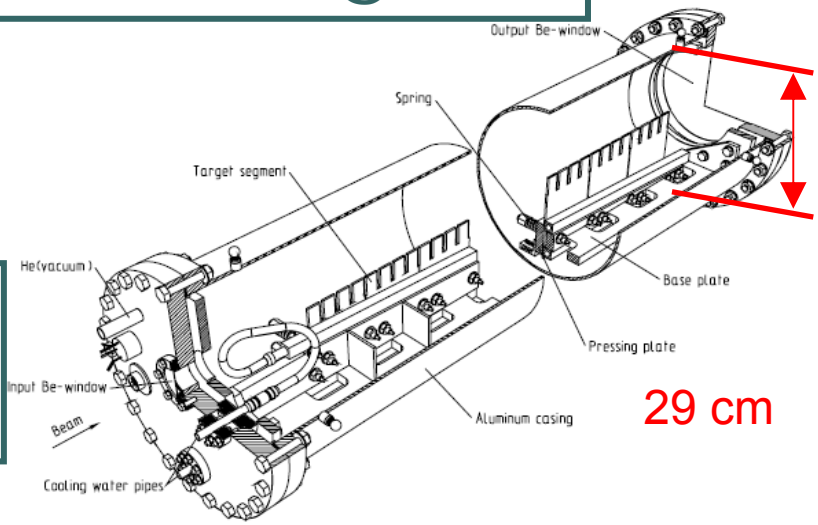
Start Thinking Now
Early Investments Payoff
Don't Skimp

DUSEL beamline compared to NuMI

- Power is 3-5 times the NuMI design power
  - More shielding, cooling, rad component handling (NuMI Horn 1 could reach ~400 R/hr @ 700 kW)
- High target power and low energy neutrinos
  - (See next slide)
- Decay pipe
  - ~400 meters versus 675 meters for NuMI
  - Radius of ~2 meters versus 1 meter for NuMI
- Downward bend of 5.8° versus 3.3°
  - Shaft will be deeper?
  - Enter the Galena-Plattville Rock?
- Near Detector Hall
  - More rate means smaller detector



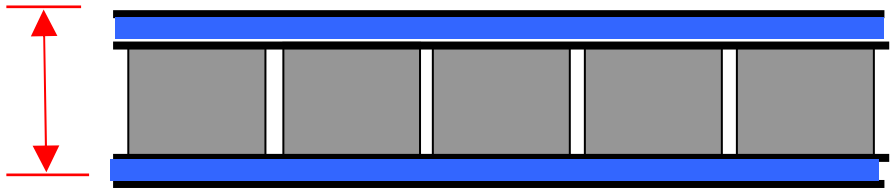
MINOS 400 kW
LE Target OD = 30 mm
Horn ID = 18 mm @ Neck

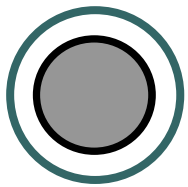


29 cm

NOνA 700 kW
ME Target
External to Horn

~25 mm





IHEP 2 MW
Conceptual Design
Needs to fit within neck

Annular channel for water cooling

Target material? Graphite? Carbon Composite? (BNL working this.)
Cooling? Can we get adequate cooling? Water cooling OK?
How to fit within the Horn?

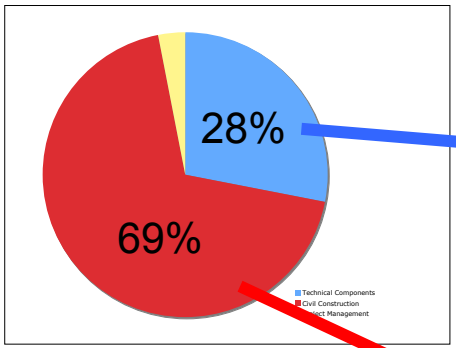
Decisions Needed

- Primary Beam Energy
  - 60 - 120 GeV is possible; choice affects the primary beam transport, beam losses, etc.
- Target-Horn Configuration
  - Affects Target Hall dimensions; shielding arrangement….
- Decay Pipe Length and Radius
  - BIG impact : excavation and shielding
- Need for muon monitoring stations
  - Prove they are needed
- Near Detector technology and size

High Priority RD&D Work

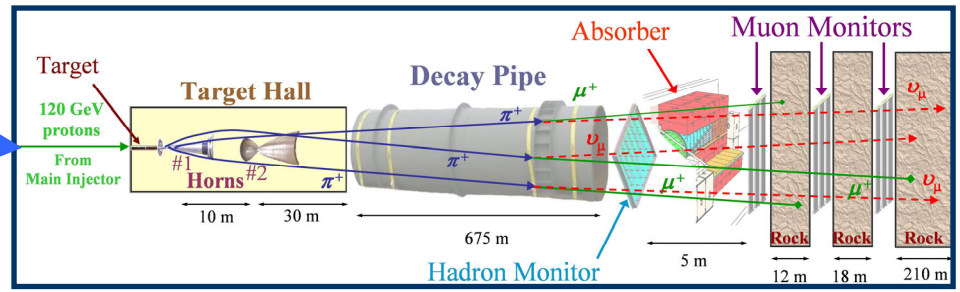
- 2.3 MW Target and Horn
- Radiological Calculations
- Decay Pipe, Target, and Horn Optimization
- Remote Handling and Storage of Components
- Project Definition Report for tunnels, halls, SB&O (Needed for an updated cost estimate)
- Core Samples

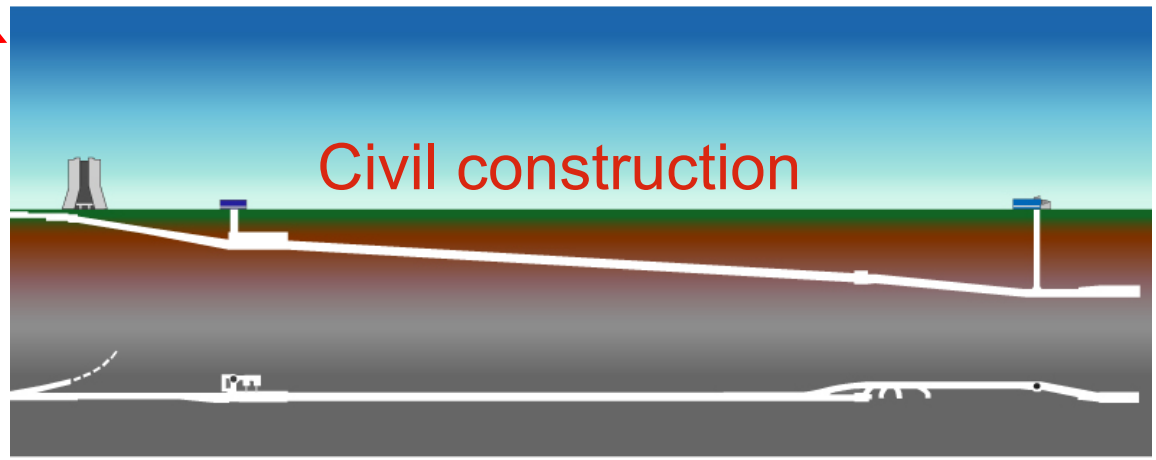
Starting Work on Cost Estimates



NuMI Project Cost

Technical Components





Project Office Team

- Project Scientist or Director
- Deputy Project Scientist or Director
- Project Manager
- Deputy Project Manager
- Control Account Managers (CAMs)
- Subproject Managers (i.e. Level 2)
- Subproject Leads (i.e. Level 3)
- Project Controls (Schedulers w/EVMS)
- Project Budget Manager/ Specialist Senior/Specialist
- Project Engineers (Mechanical, Electrical/ Electronics, Civil)
- System Integration Engineer
- Project Chemist
- Project Integration Manager
- Project Procurement Administrator/Specialist
- Project Risk Manager
- Project Configuration Manager
- Project Quality Manager
- Project ES&H
- NEPA Coordinator
- Project Webmaster
- Project Database Manager
- Project Administration

Prepared by Fermilab OPMO, Dean Hoffer

Summary

- Able to Fit Beamline on Fermilab Site
- (Very) Preliminary Horn-Target Configuration
  - Shows we can get reasonable ν spectrum
- 3-5 $\times$ Power $\Rightarrow$ New Challenges
  - Targetry, Radioactive Component Handling, ES&H, …
- Started DUSEL Beamline Working Group
  - Has been mainly focused on NuMI Lessons Learned
- Significant R&D work still needed
- Improved Cost Estimates require:
  - Decisions on Beam Parameters
  - Start of Project Office